ATTACHMENT 3

PROJECT NEWSLETTERS

The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

Vol. 1, No. 1 November, 1998

OUR FIRST ISSUE!

The Watershed will be our way of keeping our cooperators, county agents, and others informed as to our progress. We plan to publish it quarterly. The Grazing Land Water Quality Education Program is now approaching 2 years old and growing. Much has happened during this time.

Upgrading Our Technology

Over the winter, the project moved from paper mapping and data collection to global positioning system (GPS) and geographical information system (GIS) technology for data collection and management. This change will allow more detailed data to be developed and more robust statistical analysis to be used.

What Are We Learning from the Project?

The major trends developed to date focus on two types of concerns: those directly related to grazing land and those related to non-grazing land. On grazing land, the major concerns are forage utilization, undesirable species invasion, and animal concentration. Animal concentration appears to be the need for shade or for higher quality forage or water. Most of these concerns can be changed through management changes or development of new facilities. New facilities may include alternate water supplies or cross fencing. Alternate water supplies may be developed to change grazing distribution or to provide a higher quality water supply.

Non-grazing land concerns usually are not controllable by the operator. Runoff from cropland onto grazing land is a major concern. The runoff can be from terrace and waterway systems or from uncontrolled runoff. In both cases, the water is concentrated in a narrow runoff area increasing the volume and velocity of the flow. The result is erosion in drainages and streams. Incising and widening of the channel are often the result.

Another source of concern is from public transportation areas such as roads. An example is a culvert. Routinely, the stream channel is incised on the upstream side and an eroded hole created on the downstream side. In both cases, erosion of the stream channel occurs in both directions, changing the physical aspects of the channel. The exact nature of the changes depends on the soil characteristics, slope, and land management.

Historic land use policy and decisions also play a role. Some erosion can be traced to the Homestead Act and other government programs. Old fields, especially on hilltops or hill sides, have created distinct erosion patterns downslope. Some areas have recovered while others are still recovering. Fence lines, governed by the Public Land Survey System or to serve as property boundaries, often are in locations that create erosion. Many circumstances can create the erosion including pasture roads, cattle trails, and runoff patterns.

Based on the data available, assessment of water quality concerns on grazing land must include a review of the watershed above and below the pasture. Water quality concerns on a single tract of land can not be solved until the role played by other parts of the watershed are identified, understood, and included.

What we are Telling Others

During the last year, we have had several opportunities to explain our project to others. At the annual meeting of the Society for Range Management, we had a poster entitled A Grazing Land Water Quality Education Program. The poster was also displayed at the

"Water and the Future of Kansas Conference," "Building Clean Water Communities Conference," and the Pottawatomie County Cattlemen's meeting.

A second poster and a proceedings paper were accepted for the American Water Resources Association "Speciality Conference on Rangeland Management and Water Quality." The poster entitled A Grazing Land Water Quality Education Program for Producers was also displayed at the Nemaha County Free Fair, the Pottawatomie County Fair, Bressner Pasture Field Day, and K-State Research and Extension Annual Conference. The poster features an 80 acre pasture of one of our cooperators and details of what we are finding and some management suggestions for improving water quality. The proceeding paper is also on the Internet at http://awra.org and go to the on-line proceedings for the conference. If you have a meeting or event that you would like to have one of the posters displayed, let us know.

Some Changes in Our People

Two people have left the project: Erek Fuchs and Mark Dikeman.

Erek Fuchs, Extension Assistant in Agronomy, started with the project in January, 1997. He was instrumental in the design and workings of the project. Effective August 2, 1998, Erek became the Water Resource Specialist for the New Mexico Department of Agriculture. This is a new position so Erek will be helping shape its future. We wish Erek and family success and hope the future is good to them.

Mark Dikeman, Graduate Research Assistant Agricultural Economics, has moved to Des Moines where his wife will be in law school. He will be finishing his thesis developing an economic analysis case study for water quality changes based on a pasture of one of our cooperators. We wish Mark and his wife success and hope the future is good to them.

Rodney is now searching for an Extension Assistant to conduct the economic analysis of the cooperator's enterprises. Three new people have joined us: Will Boyer, Larry Huber, and Ryan Sigg.

Will Boyer will be the new Extension Assistant in Agronomy responsible for the literature review, field data collection, and data analysis. Will was born in Nebraska but grew up in the Washington D.C. area. Many of his childhood summers were spent helping grandparents and uncles on family farms and ranches in Northern Minnesota and the Sandhills of Nebraska. Will attended Chadron State College in Chadron, NE receiving his bachelors in biology. From 1990 to 1993 he helped his aging grandfather operate the family ranch. Prior to coming to K-State Extension, Will served five years as General Manager of the Upper Loup Natural Resources District. Will is engaged to be married to Darla Allen, a Wabaunsee County native. Will's interest include various forms of outdoor recreation and spending time with friends and family.

Larry Huber is the Extension Assistant, Geographical Information Systems (GIS). Larry's background is in GIS having worked in the KSU Department of Geography's Geographic Information Systems and Spatial Analysis Laboratory (GISSAL). He has a keen interest in water quality in the State of Kansas and is proud to be helping to improve it by being a member of the Kansas Grazing Land Water Quality Program. Larry enjoys fishing and photography and watching K-State demolish other Big XII teams!

Ryan Sigg is our Web Page Designer. Ryan is a senior at Kansas State University, majoring in Management Information Systems and General Management. He is also a part time building manager at the K-State Student Union. Ryan is an assistant coach for Hornets football, a 5th grade team in the Northeast Kansas Football League. He enjoys mountain biking, weight lifting, and spending time with friends.

Field Work Moves Slowly

The field inventories are moving along slowly due to learning the new data collection technology, the weather, and Erek's leaving. To date , we have inventoried about 9,000 acres and have about 2,500 acres to go. Some inventories

done in 1997 will be redone to document certain high priority characteristics. We plan to complete as much of the acreage as possible this Fall and complete as many of the water quality and economic analyses this winter as possible.

We Plan to Expand the Work Area

Depending on when we are again fully staffed, we will expand the work area. More on when and where later.

The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

Vol. 2, No. 1 November, 1998

Ole's Update:

Spring is here! It has been a strange winter and it makes you wonder what the rest of the year will be like. Weather permitting, we'll be returning to the field as much as possible.

Staff Our staff is now at full force with the arrival of Gary May, Extension Assistant in Economics working with Rodney Jones. It will be nice to get the rest of the data we need and do the analysis we need.

Field Work Gary and Will Boyer will be responsible for completing everyone's data as quickly as possible this spring. We have one cooperator we need to finish the field work on. Also, we are planning to update field data on several locations we inventoried in 1997 (gee, that's a long time ago!). Will will let you let individuals know before we do the work.

Posters We are looking for events where we can display posters we have developed. Currently, we have two: *A Grazing Land Water Quality Education Program for Producers* that features a look at an 80 acre pasture of one of our cooperators; and *What are the Grazing Land Water Quality Issues?* That reviews the general factors that we feel impact grazing land water quality. If you have an event that is appropriate, let us know and we will arrange to get a poster there.

New Work Area We plan to expand the work area this spring. The new area will be Tuttle Creek Reservoir and the watersheds along it. More on the expansion later.

- - - Read on to get additional information about the above topics and more!!!

Improving Grazing Land Management Practices With GIS

Geographic Information System (GIS) technology is being used by this project to inventory and manage grazing lands to improve water quality. The GIS (we use ArcView, but there are several others) combines digital data sets often in different formats and from different sources into a single, query-able resource.

We first perform a field inventory of a cooperator parcel which is used to develop a map that includes major features such as ponds, fence lines, feeders, pasture roads, areas of observed erosion and other features. Soil data is combined with the parcel features and modified to include range site information. All data is then over-layed on top of a digital aerial photograph of the parcel in ArcView to produce the inventory map. The GIS yields greater accuracy in the determination of pasture acreage than most traditional methods of areal estimation because the GPS (Global Positioning System -- satellite -- technology) is used to determine pasture boundaries (often fence corners) and the digital aerial photograph is used to delineate the pasture (for areas that may not be fenced in) and any areas excluded from the acreage used to determine productivity, such as ponds.

Beyond mere description, we can use the GIS to determine a pasture stocking rate using range site and condition information specific to that pasture. For example, a pasture in Pottawatomie County might have 100 acres of "Loamy Upland" range, all determined to be "good" condition during the field inventory. According to the tables in Appendix C of Kansas Grazingland Management, 1999 Edition, every acre of "Loamy Upland" range site in "good" condition can support one 1,000 pound cow weaning a 400 pound calf for one month. Therefore, this 100 acre pasture would support 16-17 of the cow/calf pairs above for six months or 32 five hundred pound stockers for five months. That was a simple example. In actual

pastures, depending on size, there will usually be several range-sites of varying condition. With a simple query, the GIS will help us calculate stocking rates of each range site within a pasture and then combine them for the total stocking rate of the pasture.

The GIS may be used to aid cooperator management of resources by providing insight into 'what if' scenarios. Suppose a cooperator wanted to know how much land of a given range condition (say Loamy Upland) was within 200 feet of water, the GIS could easily generate a map showing just these characteristics for a given pasture or the entire parcel. - Larry Huber

We have a New Staff Member

Gary May is the Extension Assistant in Agricultural Economics. Gary is a native Utah and received a B.S. in Agricultural Economics at Utah State University in 1995 and M.S. in Agricultural Economics at the University of Wyoming in 1999. Gary also spent two years as a research associate at the University of Wyoming developing economic models evaluating alternative ranching practices.

Estimating Economic Impacts of Water Quality Improvements

An important component in this project is developing economically feasible solutions to existing or potential water quality problems on grazing lands. These solutions ideally would improve natural resources without adversely impacting ranch profitability. Proposed water quality solutions may entail capital improvements to physical facilities, or management changes. Physical changes could include fence construction or removal, water development, or other improvements. Management changes could include alternative grazing strategies, alternative stocking rates, or using a different class of livestock. Some solutions may require minimal investment, such as simply moving salt and mineral supplement to achieve a better grazing distribution.

The economic impact of each proposed solution will be estimated by collecting relevant management and production information from cooperators, then developing budgets that quantify costs and benefits associated with specific improvements. Proposals will be evaluated by developing profitability projections of different management scenarios. This information may be used to determine whether incentive payments to implement water quality improvement practices or strategies are needed.

Predicting the magnitude, timing, and duration of future costs and benefits is imprecise. For example, cattle prices, range condition response to management changes, and useful life of capital improvements are inherently unpredictable. Our goal is to account for this uncertainty by assigning probabilities to specific scenarios associated with each proposed capital improvement or management change. For example, we might report that a specific water quality improvement strategy may carry a 40% chance of reducing, and a 60% chance of maintaining or improving profitability. This information should allow cooperators to make implementation decisions based on their own risk tolerance and management objectives. - Gary May

Watersheds from a Historical Perspective

A review of history is an obvious but often overlooked tool for analyzing problems at a watershed level. Knowledge of the watersheds in which we are working is crucial to the identification of water quality problems. It must include an understanding of the inter-relationships among natural history, historic land use decisions, recent natural events and current land management. This knowledge helps us to distinguish between problems over which we can have the greatest influence and problems that might best be corrected by nature alone.

What we are actually observing is evidence of physical changes on the landscape. These changes may occur over hundreds of years or happen as quickly as a summer thunderstorm. These landscape changes usually result from some combination of the following three influences: 1) natural processes, 2) historic public decisions, and 3) historic private

management decisions. Relevant natural processes include: rain events (timing, frequency and severity of particular events), stream channel development, natural erosion, and the natural contribution of contaminants. Physical changes significantly influenced by historic public decisions are fence line erosion resulting from fence placement dictated by the Public Land Survey System; erosion on revegetated abandoned cropland; drainage alterations resulting from public transportation systems; and woody plant invasion resulting from fire suppression. Examples of physical changes influenced by private land-use decisions include: vegetative changes such as conversion to cropland or changes in range condition, the development of new facilities and/or the abandonment of old ones, failure of undersized dams, soil erosion, and the silting of ponds.

We review the history behind physical landscape changes to help us understand how management changes can improve water quality. This review plays an important role in the development of sustainable and economically viable solutions to existing and potential water quality problems on grazing lands.- Will Boyer

Contact with Cooperators Set to Increase

As spring arrives our two newest staff members are preparing to hit the ground running. They will be collecting additional field, management, and economic data on cooperator parcels. Gary May, our Extension Assistant in Agricultural Economics joined our team in mid March. He will be reviewing and expanding upon cooperator management information to assure accurate economic projections can be made for any suggested management adjustments.

Since his start in November Will Boyer, our person responsible for field data collection and analysis, has taken advantage of several fair weather opportunities and has become familiar with our field data collection equipment and procedures. He will be revisiting some of the project's earliest parcels to more accurately map pasture features because we initially did not have a global positioning unit. Our study area will then expand to the south along and near Tuttle Creek Reservoir, and then to other watersheds throughout the state.

The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

Vol. 2, No. 2 November, 1998

Ole's Update

The old children's rhyme of "Rain, rain, go away..." is a tempting one these days. But, we may be on the other side wishing for rain in a couple of months! Still, it sure messes up working in the field.In this issue, we are putting together brief descriptions of some of the things we are doing to better understand water quality and grazing land. Will takes a look at why we need to assess what is happening in the pasture and the need to be aware of what surrounding land may be contributing. An example of how we are using GIS is a process Larry has developed one data source into another we need. Gary explains the economic procedure we are developing to evaluate making management changes to reduce the potential for water pollution. These articles may give you a better idea of the process we are developing for landowners and operators to use in understanding the potential for grazing lands to pollute.

Water Quality and Enterprise Profitability

The predominant land use in the watersheds we are surveying is grazing but we are finding other factors influencing water quality. For example, other land uses such as roadways and cropland can significantly contribute to stream sediments when soils are exposed and natural drainages are altered. Sediments are delivered to streams from erosion of exposed soils and from road grades and terraces channeling water more directly to the streams causing stream bed and bank erosion. A question one might ask is, how significant are these localized influences in comparison to livestock on grazing land? Rather than spending a lot of time and money trying to find direct answers to questions like this, we seek to promote grazing management that will minimize livestock influences while maintaining or improving profitability. Something key to most of the recommendations that we will offer is the use of livestock distribution techniques to reduce trampling and over-utilization of sensitive areas. Improved distribution will both increase profitability and decrease the potential for livestock contributing to water quality impairment.

Of course there will always be places in a pasture that livestock will graze harder or trample more. When needed, simple management adjustments can often be made relocate these "sacrifice" areas so they will not negatively influence water quality. Strategic placement of salt, mineral and fly control facilities is a simple way to accomplish this and at the same time get more from the pasture. Periodically moving winter feeding locations is another inexpensive way to entice livestock to under-utilized areas. Other beneficial improvements may involve some capital investment. People with large pastures having only one watering location may be able to justify the expense of an additional water source. Similarly, fencing a stock pond and installing a trough below could decrease pond sedimentation and extend its useful life.

These are just a few examples. Improvements that may benefit one operation would not necessarily benefit another. The potential for improvement and the means for reaching that potential will be unique for every pasture of every operation . There will be no one size fits all management prescription. We are developing a process to guide producers through a water quality, production, and economic evaluation of their unique resources. While the process will be for a pasture, the impact of the watershed must be considered also. It will be a

decision making tool that individual cooperators can use to address actual and perceived negative impacts that grazing livestock have on water quality. - Will Boyer

Collecting Data to Conduct a Standardized Performance Analysis (SPA)

We have begun the initial phase of our economic data collection, and wish to thank those who have already shared information with us. Our goal is to develop standardized performance analysis (SPA) type data for each cooperator. SPA was initiated by the National Cattlemen's Beef Association and developed in a cooperative effort by several universities. SPA is a system of standardized procedures for measuring asset productivity and profitability of livestock enterprises.

Standardized calculation procedures allow individual producers to directly compare their productivity to industry benchmarks on a local, regional, and nationwide basis. Key performance measures generated by SPA include production costs per pound of animal produced, pounds produced per acre of grazing land, return on assets, and several others.A critical component of SPA is collecting accurate financial and production data. We are interested in financial information that will allow us to construct beginning and ending balance sheets, and an accrual adjusted income statement on the livestock enterprise. Accrual adjusted financial statements account for inventory changes. Production data needed for SPA includes weight gains, reproductive and weaning percentages, along with inventories and inventory changes.

Changes or capital improvements recommended to reduce erosion and promote water quality should be compatible with the cooperator's management objectives, and not exceed financial constraints. In addition, potential management changes or capital improvements on a single pasture often impact other aspects of the operation that simple partial budgeting may not account for. SPA based enterprise analysis will help us evaluate management alternatives in an entire management context and consider the cooperator's financial position before making specific recommendations. SPA is not a decision making tool in itself, identifying the most profitable management strategy will require further analysis. Information generated from SPA, however, will provide a basis for comparing the profitability of proposed changes to the status quo, an allow us to compare management alternatives on an "apples to apples basis."The worksheets used to compile SPA input information may appear overwhelming. Completing the data sheets, however, is not as formidable as first appears. Cooperators participating in the Kansas Farm Management Association may already have much of the financial data available. Schedule F on the tax returns can also be a good place to start. Collecting all of the required data is difficult in one setting, and may require follow-up calls. We value each cooperator's time commitment and wish to make the data collection process as efficient as possible. As always, all financial information provided by cooperators is strictly confidential - Gary May

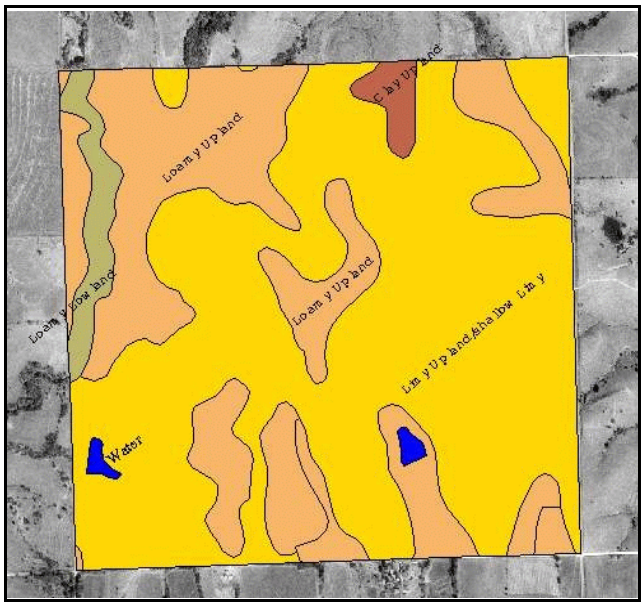
Constructing a County Level Range Site Coverage

Using data from the state GIS clearinghouse [Data Access and Support Center (DASC)], we have developed a methodology to combine NRCS soil digital data to obtain a dataset that contains range-site information on a county level. The range-site coverage will allow us extract any digitally-defined area (such as a parcel boundary) and then add parcel-specific information (such as range-site condition) into the database.

Without such a procedure, the range-site data would have to be generated by using the soils data as a background coverage and the range-site boundaries would have to be manually-digitized. This is a time-intensive procedure would have to be repeated for each parcel of each cooperator. With the development of a digital range-site database for the entire county, we now have rapid range-site information available at the parcel level which we can use in further analyses such as the

calculation of total pasture AUMs.

The figures below represent a randomly selected section in Pottawatomie County. The top figure illustrates the boundary of this parcel overlaid on digital orthophotography. The bottom figure represents the county range site coverage clipped to the boundaries of this parcel and labeled with the range site designation. - Larry Huber



The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

Vol. 2, No.3 November, 1998

SPECIAL GIS/GPS EDITION

This edition of the Watershed will focus on the application of geographic information system (GIS) and global positioning system (GPS) technologies to the management of grazing lands.

OLE's UPDATE

Larry Huber discusses GIS and some of the ways we use it to handle data. We think there is a high potential for GIS to become more than a research and inventory tool. We are including a brochure on the K-State Agronomy Farm Field Day August 25, 1999. We will have a large display on the project showing what we are doing and developing for future use. See you there.

WHAT IS GPS?

Simply put, GPS is a tool used to obtain accurate positions using satellite signals. GPS is already being used in precision agriculture applications such as yield monitoring and/or mapping, site specific soil sampling, field boundary mapping, and variable rate applications (such as nutrients and lime). For livestock applications, GPS is being used to study cattle movement dynamics at Montana State University. A similar study involving the monitoring of body temperature, ambient temperature, body weight and activity level is underway at the University of Kentucky.

In the Kansas Grazing Land Water Quality Education Program, we use GPS to establish the coordinates of fences, gates, springs, troughs, mineral feeders, and other features. The position of fences is particularly important because these define the extent of the pasture and are used by the GIS to calculate total pasture area.

WHAT IS GIS?

A geographic information system is software used to store, retrieve, manipulate, analyze, and portray data usually associated with a location. For example, the GPS data we collect from a pasture is input into the GIS so that all features may be "seen" together. To aid in this visualization, we display pasture features over a digital aerial photograph of the pasture.

WHY USE GIS?

Perhaps the most basic question a grazing manager needs to know is how large his/her grazing resources are. An accurate answer involves first determining the acreage available within the fence, which is rarely the same size as the parcel of land the pasture is in — even if only one pasture occupies the entire parcel. Secondly, unproductive areas and/or areas unavailable for grazing (such as ponds, streams, and dense wooded areas) must be removed from the equation.

A major strength of GIS is its ability to combine information from diverse sources into a single visual environment. Beyond merely determining an accurate area for a pasture, GIS can add publically-available, low-cost (or free!) data that may already exist -- such as soils-- to user-generated data. The major restriction here is the data format in which the information is contained must be readable by the GIS software you use.

We routinely use the township/range (PLSS) and soil (SSURGO) databases available from the Data Access and Support Center (DASC). Their Internet address is:
http://gisdasc.kgs.ukans.edu/dasc.html

We use the soil data to derive the range site database by combining different soils which have the same range site designation – Loamy

Upland for instance. To this range site database we add an assessment of the condition of the site. This information can then be used to estimate pasture stocking rates. (See March 1999 Watershed for a discussion of AUMs and stocking rates.) Such information is critical to our project because over-stocking and animal concentration often lead to reduced vegetative cover which can accelerate runoff and erosion both of which may degrade water quality.

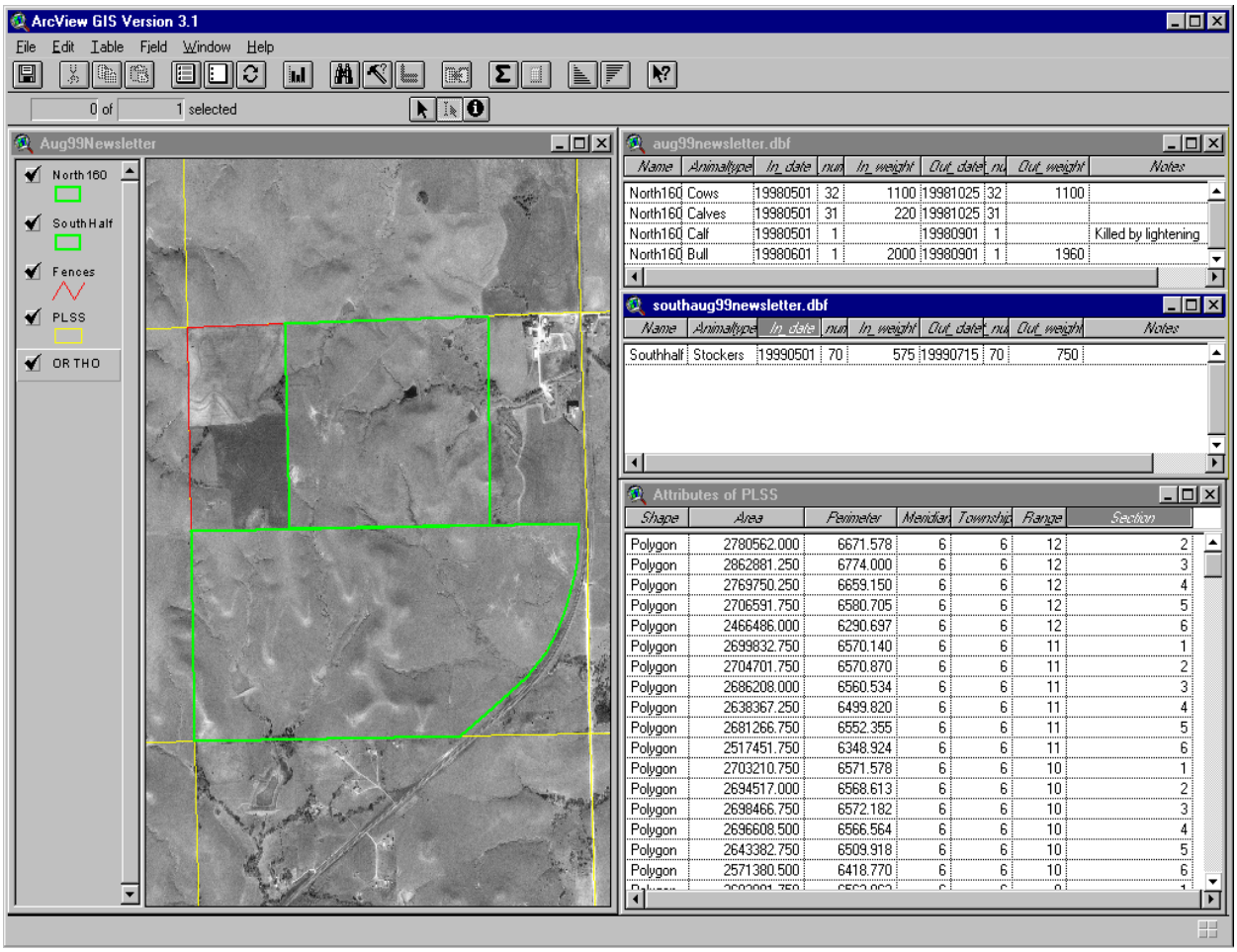
GIS FOR RECORD-KEEPING

GIS can be used to store some or all information important to the grazing manager in a central location for efficient planning, record-keeping, and management. A grazing manager can record pasture information such as stocking rates, turn in/removal dates, and maintenance expenses, directly into the GIS. Then by simply clicking on that pasture, all information linked with it can be reviewed. The same is true for other information such as charts, diagrams, graphs, photographs or entire multi-media presentations.

In addition, existing computerized pasture records can easily be incorporated into a GIS. Further, information may be linked via a column in a database that is identical to a column in another, because tables in GIS are relational. For example, if a manager had livestock data in a spreadsheet, he or she could link this information to pasture data already in the GIS.

THE FUTURE

In the not too distant future a grazing land manager will have the capability to observe the movement of livestock on-screen as it occurs!



An example of a GIS screen (in this case ArcView 3.1) showing a digital orthophoto on the left overlayed with pasture boundaries (in green), fences (red), and the Public Land Survey System (PLSS, in yellow). Pasture utilization records are shown in the upper right and the PLSS data in the lower right.

This could be accomplished by tagging all livestock, or, more realistically in the near term, tagging a few animals or even a single animal. Physiological indicators such as temperature, heart rate, and activity level of individual animals will be capable of being monitored remotely. An alarm could sound if monitored levels reach a specified threshold indicating an animal is under stress. Similarly, an alarm could indicate an animal has strayed outside a user-defined area indicating that animal may be lost.

GIS/GPS SITES ON THE INTERNET

http://www.esri.com
http://www.magellangps.com/
http://www.mapinfo.com/
http://www.trimble.com/
http://www.intergraph.com/
http://data.geocomm.com/
http://www.usgs.gov/research/gis/title.html
http://www.GISPortal.com/
http://www.geo.uni-bonn.de/members/haack/gis-software.html

CALENDAR

August 18, 26, 1999
KLA-KSU Ranch Management Field Days
Start at 4:00 pm with barbecue at 7:00 pm

August 25, 1999
KSU sponsors Agronomy Field Day
Manhattan, Kansas

September 1-2, 1999
Kansas Section of the Society for Range Management Fall meeting in Medicine Lodge, Kansas

The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

Vol. 2, No. 4 November, 1998

OLE's UPDATE

Stocking rates and grazing distribution are the most important grazing management principles influencing water quality. Other principles important to grazing management are also discussed in this issue of the Watershed.

Ryan Sigg, the web page designer, is graduating in mid-December and will be leaving. His replacement, **Scott Hussey**, has already joined us.

Managing Grazing Land for Water Quality

Grazing land managers can minimize water quality problems by practicing good grazing management. The key is having a good understanding of livestock behavior. Careful application of common grazing management principles to manipulate behavior can help managers remain profitable while minimizing adverse impacts on water quality. How grazing management strategies are applied will depend on the topography, productivity, and vegetative type of the grazing resources; and management resources such as livestock, fences, water, time, and management ability.

We are finding good vegetative cover to be a dominant influence in reducing pollutants attributed to livestock grazing from entering public waterways. Good vegetative cover benefits both forage productivity and water quality. Grass cover benefits water quality by stabilizing soil and filtering sediment, nutrients, bacteria, and other potential contaminants.

Poor vegetative cover on grazing land is caused primarily by concentrated livestock use. Potential water quality problems occur when congregating livestock trample or over-graze sensitive areas such as in draws and near streams.

Stocking Rate

Excessive stocking rates are a potential management influence on degraded water quality. Stocking rate is the single most important management variable affecting grazing land water quality and sustained profitability. Stocking rate is defined as the land area allocated to each grazing animal for a specific length of time.

Several pasture variables influence the "proper" stocking rate. The most obvious considerations are forage availability and quality, primarily influenced by climate, soil quality, and historic use. Inaccessible or unproductive areas of the pasture, such as brush, rocks, ponds, and areas of unpalatable species should not be included in the stocking rate calculation.

Some pastures are more suitable for specific uses than others. For example, terrain and proximity from headquarters may limit the type of livestock and the time of year most suitable for grazing. These are important to determining pasture stocking rates because the physiological needs of the animals will vary depending upon the grazing species, the animal's age or reproductive stage, supplemental feeding, and weather conditions.

Appropriate stocking rates should also consider past and future changes in the kind, class, and size of animals stocked on the pasture. Forage preference varies with animal species and life cycle. For example, sheep generally prefer forbs while cattle prefer grass. Younger animals are willing to expend more effort to find palatable forage. Lactating cows require more nutrients than dry cows. This suggests pastures should be stocked according to the unique characteristics of animals, forage and terrain of the pasture.

Stocking rates are limited by the grazing capacity of other pastures in the grazing system. For example, heavy stocking rates on summer pasture may not be profitable if supplemental feed is required to offset a forage deficiency. This implies stocking rate decisions carry widespread, often subtle consequences over the entire grazing enterprise.

Economic conditions such as cattle prices, interest rates, operating costs, and lease terms will also impact the profit maximizing stocking rate. Since livestock enterprises exist to earn a profit, conditions that increase per head profitability encourage higher stocking rates. However, economic studies suggest that moderate stocking rates are usually more profitable than heavy stocking rates, even in the short term.

Grazing Distribution

Even properly stocked pastures can degrade water quality if grazing patterns are distributed unevenly. Poor grazing distribution reduces vegetative cover in over-used areas while leaving forage in less convenient areas un-harvested. A uniform grazing distribution benefits both profitability and water quality.

Improving grazing distribution requires management of animal movement and selective grazing behavior to create a mosaic of vegetative cover that is generally uniform over the pasture. To protect water quality, concentrated use in draws or near streams should be minimized by enticing livestock to spend a greater amount of time in other areas.

Distribution problems are influenced by the location of water and shade in relation to terrain, prevailing winds, and palatable forage. A variety of grazing management tools can be used to improve grazing distribution. The simplest and often most effective tool for managing grazing distribution is the strategic placement of salt, mineral, supplemental feed, rubs and fly control facilities.

Removing abandoned facilities or trees can also improve grazing distribution. Abandoned fences and hedgerows restrict livestock movement. Shade trees and abandoned farmsteads often encourage livestock to concentrate in water quality sensitive areas.

Prescribed burning is another widely used tool for improving grazing distribution. Burning removes coarse, undesirable forage, leaving more palatable new growth accessible. Research suggests grazing burned pastures improves weight gains in stocker cattle in the year of the burn.

High-density/short-duration grazing strategies (management intensive grazing) can improve grazing distribution. Higher stock density for short periods increase inter-animal competition for forage and reduce selective grazing opportunities. Studies evaluating the productivity and profitability management intensive grazing have generated mixed results. Implementing this type of grazing system often requires a substantial investment in livestock and management facilities. Careful, attentive management is also critical.

Some grazing distribution problems can only be alleviated by improvements requiring significant capital investment. For example, water located near natural amenities such as wind breaks or shade creates an incentive for cattle to confine their activity to a small area. This situation is common and our experience suggests moving the water is usually the only effective way to improve grazing distribution.

Marginal profitability in livestock grazing does not support large capital investment. The costs and benefits of significant capital improvements, therefore, should be weighed carefully. These investments become more feasible as the service area increases, allocating costs to more land and livestock.

Periodic and Systematic Rest

Methods of providing periodic and systematic rest include rotational grazing, deferred grazing, and alternating season of use. Properly implemented, grazing systems that provide a systematic pasture use/rest sequence during the growing season can benefit water quality by improving vegetative cover throughout the management system. These systems may also increase both profitability and

long-term forage quality. Greater stocking densities associated with some grazing systems can improve forage harvest efficiency.

Design and implementation of use/rest systems require consideration of the manager's facilities, time and skill. Failure to match management resources to the selected system will likely be counter productive. Design and implementation also require consideration of grazing resources. Different forage types are more productive at different times of the year. Cool season grasses peak during the spring and fall, while native warm season grass production peaks during late spring and summer. Crop residues and deferred pastures are available during the fall, and winter.

Management adjustments may be necessary to maintain vegetative cover and forage use efficiency in response to changes in economic conditions and weather-related events. For example, a manager may need to adjust the timing and length of the grazing season to allow vegetation to recover from a drought or hail storm. Similarly, changes in the calf weight/price slide (price spread between calf sizes) may alter the optimal weight or class of animal stocked on the pasture.

In conjunction with proper stocking rate and improved grazing distribution, any of the various use/rest systems can improve vegetative cover and reclaim exposed soil. The potential to benefit water quality while maintaining profitability is highly dependant upon the unique characteristics of the operator's grazing and management resources. Major changes to established systems, therefore, should be approached with caution.

Summary

Improper grazing management potentially contributes to surface water contamination. Placing a high priority on water quality in the overall grazing management objectives may adversely impact profitability. Depending on pasture specific conditions, some grazing strategies may simultaneously improve water quality and profitability.

The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

Vol. 3, No.1 November, 1998

OLE's UPDATE

The KGLWQ staff all attended and presented papers or posters at the annual meeting of the Society for Range Management in Bosie, Idaho in February. A review of selected papers and posters makes up most of the newsletter this time.The Society for Range Management will hold its annual meeting in Kansas City Missouri February 13-19, 2002. This will follow the meeting in Hawaii, February 18-23, 2001.

Scott Hussey, is no longer maintaining the project Web site. Harini Devaraj, a major in Computer Science replaced him and began work earlier this month.

Livestock Behavior

Scientists from Oregon and California presented results from a study exploring factors and management actions that influence grazing distribution. Cattle on the San Joaquin Experimental range were observed for 24 hour periods. Methods included video taping and "night vision" monitoring. The goal was to better understand spatial grazing patterns, and identify management actions that predictably and effectively influence cattle distribution. Researchers identified two important factors for determining animal distribution patterns; first was the efforts made by livestock to regulate body temperature, the other was the nutrient content of soils.

Supplements placed near areas frequented by animals had a strong effect on grazing pattern. The effect of water on animal distribution was dependent on weather, season, and animal need for free water.

A study presented by researchers from Montana examined the relationship between cow social rank and time spent in riparian areas. About 300 days were spent riding pasture with 155 cow/calf pairs. The rider determined social rank of the cows, monitored insect density and recorded upland versus riparian use by each cow. High ranking cows grazed riparian areas during dry weather and upland areas during wet weather. In addition, higher ranking cows raised heavier calves.

Improving Water Quality and Profitability

A presentation by researchers from Oregon State University was titled "An Economic Analysis of Grazing Best Management Practices to Improve Riparian Functioning and Water Quality." The objective of this study was to estimate the economic impact of pumping water from a riparian stream to a watering trough in an upland location for both early and late summer grazing systems. Controlled experiments suggested the water development improved upland grazing distribution and weight gains. Late summer grazing and diverting water from the stream to a trough was the most profitable management strategy. If the assumptions of this study are valid, this is an example of a management change/capital investment that improved both water quality and profitability.

Rancher Perspectives

A unique and valuable part of SRM meetings are presentations made by ranchers offering their perspective on issues of interest. Dave Secrist from the Salmon River Cattlemen's Association reported that small riparian areas and dry washes tend to be the most difficult areas to manage. On his larger riparian areas, a relatively inexpensive watering facility located away from the stream, but still within the riparian area, is effectively protecting stream-side vegetation. Secrist also showed graphic examples of non-grazing

influences on water quality such as erosion from roads, flash flooding, and wildlife damage. These non-grazing influences are consistent with what we are seeing here in Kansas.

Cassie Cady from Martindale, Montana reported on "How Ranchers Use Science in Land Management". She explained that ideally, science should be easily understood, unbiased and repeatable. Ranchers follow a scientific method in everyday creative problem solving weighing what is learned from outside sources against personal experience and then choosing a course of action. She continued by reminding conference participants that ranching is a rigorous business requiring application of a variety of scientific disciplines. Cady concluded by suggesting that SRM can help by using a consistent and understandable working vocabulary, educating ranchers and others about sustainable livestock use of rangeland, promoting the hiring of range-trained people to do range work, and by helping to differentiate between valid, impartial science and opinion.

Bob Budd, manager of a Nature Conservancy ranch near Lander, Wyoming, explained how they annually map vegetation use in their pastures using visual estimates from horseback and 4-wheeler. Vegetative indications and animal behavior are used to determine when it is time to change pastures.

Sid Goodloe, a rancher near Capitan, New Mexico, explained riparian and upland restoration efforts on his land. Goodloe observed historical evidence suggesting that both productivity and water quality could be enhanced by addressing problems with upland brush and associated erosion. Extensive prescribed burning improved productivity, re-established perennial water, and attracted wildlife back onto land from which they had disappeared.

Comments on NRCS range site classification were made from a holistic perspective by J. Southworth of Seneca, Oregon. He suggested that: "Range site classifications help ranchers reconcile the productive potential of rangeland with their own goal for the landscape. However, they may be too detailed to aid in long-term planning for an operation. Reducing the precision of range site classifications may actually increase their usefulness."

Southworth suggested range site evaluations are useful in estimating forage production and as an index of species diversity. He added the utility of range sites will increase in the future when, according to his estimation, grazing on public lands will decrease, putting more pressure on private ranchers to increase production. He suggests that using range sites to compare present condition with historical plant communities will allow ranchers to assess to what extent production increases can be accommodated.

Relating Western Perspectives to Kansas

Conference observations illustrate scale is important in planning and management. The scale at which ranchers in the mountain states manage is very different than here in Kansas. Similarly, the size of pastures and management units within Kansas vary, consequently, so does management and strategies for improving grazingland resources within our state.

Many of the presentations at this conference were made by people working on western rangelands. Although there are considerable differences, the insights they have gained in dealing with public lands issues, endangered species and water resources can be of value to Kansas as we are faced with increasing public demands on private grazinglands.

Several presenters pointed out that range management is not an exact science. Rather it requires the integration of knowledge from many disciplines. Managers are challenged further by continual shifts in weather, prices and societal demands. For these reasons the concept of adaptive management was often emphasized. With these commonalities in mind, it becomes easier to relate the experiences of researchers and managers from across North America to grazinglands here in Kansas.

Much concern for water quality in the West seems to be expressed in terms of fish habitat, a large percentage of which is on private land. Just

as private landowners in Kansas may soon be required by the Clean Water Act to reduce levels of contaminants such as sediment, phosphorus, and fecal coliform bacteria, so too are landowners in Western states likely to be required to reduce stream temperatures for fish.

Reducing livestock use of riparian areas during the growing season was a strategy discussed to promote stream-side vegetation, which shades the stream, stabilizes banks, slows runoff and captures sediment and other contaminants. Fencing and using managed grazing should be considered a last resort strategy, used only on severely degraded reaches, and then only until they are recovered. Most presenters recommend rotational grazing allowing for rest and regeneration of stream stabilizing vegetation to maintain riparian "proper functioning condition."

What Do YOU Think?

We at *The Watershed* would like to know what you - the reader – would like to see in future issues. We value your opinions so please feel free to contact any of us (contact info on back) with your thoughts and/or suggestions for specific topics or themes for upcoming issues.

New Items

A five-year study in Canada suggests stocker cattle drinking clean water gain 20% more weight than cattle drinking pond water. Next issue will review the work to see how it fits Kansas!

We will shortly be requesting nominations for new cooperators state-wide. County Extension Ag Agents will be asked to make the nominations. Details on the qualifications and requirements will be sent to agents in the near future.

The Watershed

K-STATE Kansas State University
RESEARCH AND EXTENSION

Vol. 3, No.2 November, 1998

Ole's update

My role in the water quality project is changing. As of June 19, I have assumed the State Leader position for Extension Agronomy. This will mean I will be less involved in the field work but I will remain very active in the interpretation of data and developing management option phases.

We have two new student aides this quarter. Gabe Schlickau hails from Argonia, KS and will help with field work and literature research. Stacy Stoltenberg is from Pipestone, MN and will be providing much-needed data organization and entry.

New perspective

Previous issues of *The Watershed* discussed influences livestock have on water quality and described situations in which management adjustments can benefit both water quality and grazing enterprise profitability. For example, practices that improve grazing distribution can both increase forage utilization and improve vegetative cover near streams. This issue will approach water quality from a different perspective by looking at the importance of a fresh and reliable water supply.

Water Quality and Stocker Weight Gain

Recent research suggests producers may benefit from improving the quality of water in stock ponds. An on-going study conducted in Saskatchewan, Canada compared stocker cattle weight gain under four stock-watering treatments. Treatments included: 1) cattle allowed direct access to a pond, 2) untreated pond water pumped to a trough, 3) aerated pond water pumped to a trough, and 4) coagulation and chlorinated pond water pumped to a trough. Weight gain differences among watering treatments were greater early in the grazing season when forage quality was higher. Over the entire grazing season, pumping untreated water from a pond to a trough did not generate a substantial weight gain improvement over drinking directly from a pond. However, allowing steers to drink aerated pond water pumped to a trough improved average daily weight gain by approximately 0.3 to 0.4 lbs. Treating the water with coagulation and chlorine provided weight gain benefits similar to gains noted from aeration.

Weight gain improvements appeared to be driven more by improved palatability from aeration or coagulation rather than improved water chemistry which was already below recommended limits. Researchers speculated that weight gain improvements could be attributed to greater water consumption, which in turn, increased feed consumption. Over the length of the grazing season, the researchers estimated that yearling cattle drinking aerated water pumped to a trough consumed 17% more water than cattle with access to unaerated trough or pond water.

While this research documents a relationship between stockwater quality and cattle performance, more research exploring production responses to these watering treatments are needed to assess their production and economic benefit – especially in other regions. The economic impact of implementing any of these treatments depends largely on the costs, which were not provided in the report. These watering systems appear to increase forage consumption without increasing forage production, which may impact carrying capacity and stocking rates.

The economic impact of these watering treatments may also depend on the type of

grazing operation. In the month of June, average daily weight gain improvements from aerated water were as high as 1.0 lbs over untreated pond water. Greater weight gain benefits early in the growing season suggests this type of water quality improvement may be more economically favorable to producers who operate under early intensive grazing. This study did not measure the impact these watering treatments would have on cow/calf production. Some of the benefit increased feed consumption may go toward unnecessary fat on the cow, lowering the economic benefits relative to stocker cattle. These investigators will examine water quality impacts on cow calf production in the future.

Factors Affecting Water Consumption

The Canadian study suggests inadequate water consumption adversely impacts animal performance. Livestock health is also dependent upon adequate water consumption. Extension Veterinary and Toxicology Specialists at Texas A&M believe livestock health problems usually do not result from water of poor quality but rather from stress caused by inadequate water consumption. Livestock water requirements depend upon climate, the physiologic stage of the animal, level of activity, and the dry matter content of the diet. Changes in these factors may cause consumption to vary greatly. As a general rule, dry cows need about 8-10 gallons of water per day, cows in their third trimester of pregnancy drink up to 15 gallons per day, and those producing milk require 5 times as much water as the volume of milk produced. Common signs of insufficient water intake include constipation, decreased urine output, infrequent drinking, decreased milk production and loss of body weight.

Taste and temperature of the water will also influence consumption. According to the North Dakota State University Extension Service, water temperatures ranging from 40-65 degrees are ideal and steers drinking cooler water often improve weight gain.

Unpalatable water is often a result of high levels of naturally occurring substances dissolved in the water. Accumulation of dissolved salts containing chlorides, sulfates and bicarbonates of calcium, magnesium and sodium are a typical cause of decreased water intake. Total Dissolved Solids (TDS) levels in the range of 4,000 to 5,000 parts per million may cause an initial reluctance to drink but livestock should be able to gradually acclimate without loss of production.

Even when plenty of clean water is available, actual consumption can still be a problem due to poor accessibility. Livestock may not drink sufficiently if the water is difficult or dangerous for the livestock to access. A prime example is the muddy shorelines resulting from low stock pond water levels being experienced this spring in Kansas. Muddy shorelines can cause a range of problems including hoof-rot, leg injuries or even death. Similarly, unstable footing due to loose rock, wet cement or ice can easily cause injury or result in aborted calves.

Other accessibility problems include streams with steep banks, and troughs that are too high to allow smaller animals to drink or watering points with unstable footing. Troughs should be low enough so that young animals have access and shallow enough so that they will not drown if they fall in. If water storage capacity is a concern, materials can be placed inside the trough to allow animals to safely climb out should they fall in. Troughs and fountains can be elevated to prevent contamination. The elevated base should be wide enough that, while drinking, livestock can easily put their front legs on it but not their hind legs. This will decrease the chances of animal waste contamination.

Nutrients in ponds

Excessive nutrient concentration is a common water quality problem. Sources of nutrients in livestock ponds include fertilizer, animal waste and decomposing organic material. Nitrogen from these sources enters ponds carried in runoff and spring flow. Significant concentrations of phosphorus are transported to ponds usually by runoff. Nitrogen and phosphorus contribute to elevated TDS discussed above but, more importantly, high concentrations of these nutrients in the water

supply will cause animal health problems well before the water becomes unpalatable.

Although livestock can tolerate continued ingestion of water containing up to 300 ppm nitrate, the National Academy of Science recommends consumption at concentrations below 100ppm. The level of nitrates in forage is another important factor to consider when determining/estimating nitrates consumed.

Higher concentrations of nitrates can interfere with the transport of oxygen through the blood stream. Ruminant livestock have greater risk of nitrate poisoning due to rapid conversion of nitrates to nitrites by microbial organisms. Symptoms include increased urination, respiratory distress, a blue tone to the muzzle and eyes, poor coordination and trembling; often leading to convulsions and death. Less critical cases of nitrate poisoning are believed to cause poor growth, infertility, abortions and vitamin A deficiencies.

Nutrient runoff can also lead to blooms of blue-green algae during the hot dry months of summer. Toxins released by the algae can cause muscle tremors, diarrhea, poor coordination, labored breathing, liver damage and death. Poisoning is usually a result of toxin-producing algae being concentrated along the shoreline by wind.

Pathogens

Livestock water is often identified as an avenue of disease transmission. Sickness resulting from livestock waste contaminating the water supply usually affect young animals most due to their increased susceptibility. Risk of disease transmission may increase when waste is deposited directly into the water supply or, when wading livestock resuspend persistent pathogen which have settled to the bottom.

Fecal organisms such as *Cryptosporidium parvuvum* and *E. coli* are able to survive for extended periods suspended in water or attached to sediments. These organisms are a common cause of scours in calves.

Johne's Disease or paratuberculosis enters a herd from exposure to other herds, or from replacement stock. It remains viable in fecal contaminated feed and water for months and may also be transmitted by milk of an infected cow. No effective vaccination is available, preventing exposure to replacement cattle and removal of the most highly infected individuals are recommended control practices.

Leptospirosis affects young and mature animals and is transmitted by direct contact with urine or by drinking contaminated surface water. Reduced milk production, bloody urine and abortion are common symptoms. According to the Texas Agricultural. Extension Service, vaccinations protect against abortion and death, but may not prevent persistent kidney infections. Prevention includes fencing cattle from contaminated streams/ ponds and acquisition of replacement stock from tested herds.

This literature perspective was prepared by Will Boyer and Gary May.

The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

Vol. 3, No. 3 November, 1998

Ole's update

What happened to fall weather? The changes have been quick but not wet enough! A lot has been happening with the project recently. We are moving forward on a number of projects, especially writing the guide for evaluating and defining water quality concerns. The approach we will be recommending to producers is based on livestock behavior. It will involve monitoring livestock impacts on the landscape, and developing management strategies based on expected behavioral response to management changes.

This issue will discuss what we have been learning about livestock behavior and how it can be applied to water quality management.

Livestock behavior and water quality

Observing the behavioral response of livestock to weather, pasture facilities and topography is fundamental to developing successful strategies to benefit water quality. Previous issues of the Watershed have touched on how livestock behavior determines grazing patterns and the location of concentration areas. This issue will discuss livestock behavior in more detail and offer adaptable strategies for changing behavior to meet site specific goals.

Since water quality related research in the field of livestock behavioral science is limited, much of what is presented here is based on conventional wisdom from field observations and personal communications with managers and researchers.

Many factors influence if pasture runoff occurs and if runoff flows fast enough to carry pollutants to streams. Factors such as precipitation (intensity, duration and seasonality) and historic land use are beyond management control. Important factors affecting pollutant transport to water resources that are within the control of management are grazing distribution and livestock concentration.

Grazing distribution and livestock concentration are both factors that impact the vegetative cover found within a pasture. Vegetative cover is needed – especially in draws and near streams – to slow runoff so that excessive sediment, nutrients and bacteria will not reach waterways. Cover is removed in localized areas due to uneven grazing patterns and trampling in areas where livestock concentrate for water feed and/or protection from extreme temperatures. When heavily grazed areas and livestock concentration areas are identified in draws and near streams, strategies should be developed to improve cover in these areas. Such strategies may simply involve promoting use of under-utilized upland portions of the pasture.

Physiological needs

A discussion of livestock behavior should begin by identifying the basic physiological needs of the animals. Water, forage and relief from extreme temperatures are the major physiological demands that influence livestock behavior.

Thirst appears to be the most influential of the three. Watering location tends to dictate the distribution of livestock activity within a pasture and consequently grazing land influences on water quality. Grazing patterns and livestock concentration are influenced secondarily by wind direction, shade and the availability of quality forage which can be consumed efficiently. Beyond basic physiological needs, the lesser studied social behavior of the herd should also be considered when evaluating livestock behavioral influences on quality.

Watering behavior

Since watering location plays such an important role in both water quality and livestock behavior, it is important to identify what determines watering locations preferred by livestock. Livestock preference between similar watering facilities in the same pasture is usually determined by their proximity to shade and other factors that satisfy physiological needs.

Observations suggest that, all other factors being equal, livestock prefer water facilities in the following order: 1. trough, 2. pond 3. pool in stream, and 4. flowing point on stream. It is not known why livestock prefer watering from a trough and generally avoid watering from flowing points on streams. The taste of water and fear for safety are possible explanations.

Palatability and water temperature appear to influence water consumption which also influences production. From an biological perspective, increased production could be equated with improved reproductive success.

A variety of safety concerns may also exist in and/or near watering facilities. Ice, mud or collapsing stream banks may cause injury or even death. It also seems reasonable to assume that livestock may instinctively prefer watering at locations having good visibility to avoid predation.

Loafing and social interactions around watering points are other behavioral activities worth noting. Loafing may be prompted by the need to rest, ruminate and/or take advantage of evaporative cooling. Pecking order establishment and breeding also tend to prolong concentration around watering points.

Behavior influences animal concentration

Concentration areas are potential water quality concerns due to increased levels of livestock waste and due to the trampling of vegetative cover needed to reduce pollutant transport. The location of concentration areas in relation to streams generally determines their water quality significance. A preferred watering point, as described previously, is a typical example of a concentration area that may impact water quality.

In addition to being a common type of concentration area, preferred watering location is also the major factor influencing the location of other types of concentration areas. Other factors that determine concentration area locations include shade, prevailing wind direction, mineral supplement, and fly control facilities in the summer, and the availability of feed and protection from cold winds in the winter.

Shade preferences are clearly influenced by proximity to preferred water and by prevailing wind direction. Other factors believed to influence shade preference are: the presence of biting insects, the likelihood of wind blowing under the tree canopy, and the quality of the shade. Shade quality varies depending on tree species. For example, the canopy produced by broad, dense crowns of an elm or hackberry is a preferred shade source over the tall, narrow, and less dense crown canopy of a cottonwood.

Winter feeding is a significant water quality concern due to the addition of nutrients from feed and the concentration of livestock waste on winter feeding grounds. This concern can be addressed by feeding less and alternating feeding area locations. During mild to moderate weather conditions, observations suggest that livestock will graze less and concentrate more when expecting to receive supplemental feed at a specific location. Although there may be advantages to utilizing on-farm feed, many producers are finding economic advantages to reducing winter feeding when possible.

Producers considering a management strategy that includes winter feed reduction should proceed with caution. Reduced feeding should be implemented gradually so changes in animal performance can be monitored closely. As winter conditions worsen, older animals and less efficient foragers may need to be culled or separated from the herd to avoid abortion or death loss. Over time, foraging efficiency of the herd will increase and the need for expensive feed during moderate weather will decrease.

Behavior influences grazing distribution

Grazing distribution can significantly affect water quality. Runoff will begin sooner and flow

faster over heavily grazed areas relative to more moderately-grazed areas. If adequate vegetative cover does not separate these areas from waterways, runoff will increase pollutants deposited into streams. In these cases, modification of grazing behavior is needed to benefit water quality.

mproving grazing distribution requires management of animal movement and selective grazing behavior to create a mosaic of vegetative cover that is generally uniform over the pasture. To protect water quality, heavy grazing use in draws or near streams should be minimized by enticing livestock to spend a greater amount of time elsewhere.

Many of the same behavioral factors that help determine the location of concentration areas also influence grazing distribution. Watering location and prevailing wind direction are, again, most prominent.

The presence of obstructions such as abandoned fences also influence grazing patterns. Removing abandoned fences may be needed to allow unrestricted livestock movement in order to achieve a more uniform grazing distribution.

Foraging behavior will also have an affect on grazing patterns. Cattle will spend a disproportionate amount of their time in accessible areas with quality forage. This is because foraging efficiency plays an important role in determining grazing patterns. This role involves a balance between nutrient intake and energy expenditure by the animal. Soil quality, vegetation type, fertilizer application, all affect nutrient availability. Topography and distance to water are factors affecting energy expenditure by livestock to acquire nutrients.

The numerous factors mentioned here simultaneously influence pasture use by livestock. This helps demonstrate the complexity of grassland systems and the challenge of using grazing management to address water quality issues.

Successful water quality improvement strategies for grazing land are typically less straight-forward than water quality strategies for cropland. Grazing land strategies are based on principles of ecology while cropland strategies are based on more precise sciences such as physics and chemistry. Additionally, grazing land strategies must be applied indirectly through livestock behavior modification rather than directly through land or crop management.

For these reasons water quality improvement strategies for grazing land must be based on site-specific observations and be adaptable over time. Observing livestock response to management, weather and natural pasture characteristics will be key to enhancing grazing land influences on water quality.

Your help, please

We need your help to continue building a knowledge base for managing livestock behavior to benefit water quality. Please contact any staff member (see contact information on back of newsletter) giving us your experiences with how weather, landscape and/or management influence watering behavior grazing patterns and/or the location of concentration areas. The working knowledge of experienced managers is invaluable. Helping us to share this information with researchers and other managers should help benefit grazing land water quality (where needed) as well as improve the public perception of grazing influences on water quality.

The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

Vol. 4, No. 1 November, 1998

Ole's update

We hope everyone had a good beginning to the new year and the weather hasn't created too extreme a load on you! The project is beginning its last year of funding and we will be concluding water quality assessments with all active cooperators. Much of our work and experience will be incorporated into ongoing Extension grazing management education programs. Any future project initiatives will require additional funding.

On January 4, 2001, our State Advisory Committee (SAC) met to review the project and help us look toward the future. We provide high points of the review in this issue. Please send us your comments anytime.

Sac Meeting Issues

We would like to thank *Watershed* readers and others who attended the State Advisory Committee meeting at K-State for their commitment, concern, and comments. The SAC meeting included representatives from the Environmental Protection Agency, the Kansas Dept. of Agriculture, Kansas Department of Health and Environment (KDHE), State Conservation Commission, Farm Services Agency, the Kansas Forest Service, Kansas Farm Bureau, the Kansas Grazing Land Coalition, and the Natural Resources Conservation Service (NRCS), as well as producers, KSU Extension personnel and K-State faculty and staff. Attendees provided comments on Total Maximum Daily Load (TMDL), technical assistance, and education program delivery options.

TMDLs

Several producers at the meeting expressed the need for an accepted approach producers can use to demonstrate their concern for water quality and to document proactive steps taken to benefit water resources. These concerns stem from uncertainties surrounding the ability of the state to comply with TMDL requirements. TMDLs are plans submitted by KDHE to EPA which quantify pollution reduction to be achieved for individual streams and lakes.

By court decree, TMDL implementation is scheduled to occur over 10 year periods beginning between 1999 and 2006. Based on this 10-year schedule, the first basin in the program should meet established TMDL standards by 2009 and the last by 2016 [See map inside]. TMDLs of greatest significance to most grazing managers are those established for fecal bacteria. Across the state, fecal bacteria is also the parameter that most frequently exceeds "safe" levels for designated uses of water resources.

For the first five years of TMDL implementation will focus on enhanced awareness and participation in available water quality programs. Plans have (or will have) a mid-point objective that identifies a desired level of action. For example, two-thirds of the landowners responsible for sites identified as concerns should be participating in state cost share or education programs. If participation is significantly below expectations or if monitoring indicates a lack of water quality improvement, more stringent action may be taken. Although Kansas has expressed to EPA their resistance to using TMDLs as regulatory mandates, the authority to impose conditions on activities having significant pollution potential is acknowledged in TMDL plans.

One person offered that first it must be proven that: 1) the practices we are advocating actually work – that is they result in better water

quality and, 2) grazing resource managers can provide evidence that they have actually implemented these practices. Several attendees suggested photography as a viable method of monitoring grazing land resources. It was stated that experience has been that initial enthusiasm is often high for a photopoint monitoring program, but that interest and commitment to this form of monitoring wains over time. It was also suggested that the process might include low-cost methods of water quality monitoring as well as documentation describing how, where, and when these sorts of assessments are performed. It was also suggested that one of the most direct ways to evaluate grazing impacts on water quality is by monitoring runoff from a pasture after a significant precipitation event.

Technical assistance and incentives

The need for technical assistance and incentives to promote improved water quality was also discussed at the SAC meeting. Funding was identified as an obvious limitation to meeting projected needs across the State. Recently five Watershed Specialists positions were funded to work with agricultural producers on improving water quality in priority watersheds.

It was also voiced that the incentive structure of the EQIP program offers potential help for the manager who has documented needs. In some instances, incentives may not be as readily available to the manager who is already doing a good job of managing grazing resources. Developing grazing enterprise alternative management strategies with economic evaluations may be a better approach to all incentive programs.

Delivery options

A major focus of the SAC meeting for KGLWQP personnel was to get input from the attendees regarding methods for delivering the process to the target audience, i.e. to grazing resource managers. The project envisions 3 delivery options for the educational material: a field guide, producer workshops, and a producer self-help guide.

Field Guide

The field guide will be a notebook with detailed instructions for personnel working in education or technical assistance positions such as Extension or NRCS. These personnel would provide individual assistance to producers wishing to incorporate water quality planning into their management objectives. This publication will discuss relevant research and experience related to water quality to support the development of management strategies. It will also include examples of water quality problems and solutions encountered with cooperators. A record of notebook users will be maintained so that notebooks can be updated over time.

Producer Workshops

Producer workshops will consist of a series of classroom sessions and follow-up field sessions. Workshop material will be presented in appropriate formats and will include examples depicting common water quality problems associated with grazing land and discuss potential solutions. The presentation will be coordinated with a notebook describing the assessment and planning process. Extension publications describing grazing management principles and examples of practices that can be applied for water quality improvement will be included in the workshop material.

Self-Help Guide

The producer self help guide will consist of the publication Managing Kansas Grazing Land for Water Quality (MF-2086) published in March of 1995. This publication will be revised to include a less detailed description of the process than that in the field guide or the workshop material. It will include references to supporting Extension publications including those being provided at workshops.

In addition to the developed educational materials, the education program will include demonstration sites. These sites will serve two purposes. First, demonstration sites will be used to test and refine the educational materials designed for producer use. Secondly, the sites will serve to host field days that will allow other

producers to see how a water quality plan has been developed and implemented.

Comments on delivery options

One producer commented that he felt the most bang for the buck for getting grazing land managers to pay attention to water quality would be in education that would induce managers of grazing resources to incorporate water quality planning into their overall management planning.

He also offered that perhaps the best way to present the process would be first in a team format that would focus process implementation on a one-on-one basis with project staff and an individual producer. This he suggested would get the ball rolling and producers implementing the process could communicate and/or mentor with producers considering process implementation. The teamwork format could simultaneously be backed up with a workshop format where instruction could be presented to small groups of producers. He further recommended focusing on self-help materials last.

It was also suggested that when delivering the educational materials, County Agents and NRCS personnel could act as a coordinated team, not as individual experts and that coordination would ensure consistency in implementation, training, and instruction.

Because this project is in its final year, if benefits from the research, experience and observations of project staff are to live on, then funding from private sources should be considered, and in fact, such funding options are being pursued.

The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

Vol. 4, No.2 November, 1998

Ole's update

It's June, the weather has been normal, that is completely different than last year! Precipitation has been from little to more than the land could soak up, so we had runoff. And runoff is where grazing land can contribute pollutants. Runoff will always contain sediment, nutrients, and bacteria, but our management can create situations that greatly add to that background level. That's the challenge we face in KGLWQP.

Winding Down

The Kansas Grazing Land Water Quality Program (KGLWQP) will officially terminate at the end of this year. The education program we are developing however, will live on and help managers of grazing resources plan for and improve the quality of water leaving their land. Cooperators will soon begin testing the educational materials KGLWQP has developed. Their comments will be used to edit, refine and improve the materials in the education program before widespread dissemination. As a reminder to those that attended the January 4, 2001 meeting in Manhattan and to inform other readers, we are planning to deliver the education program material via one-on-one field appraisals, an on-going workshop/seminar program, and via self-help materials. These formats are described in more detail later in this newsletter.

What Would You Do?

In order for the educational materials to be the most effective, we need input from grazing resource managers regarding what kinds of approaches would work best for them to incorporate water quality planning into their enterprise operation. What works best for you? What approaches have you seen at conferences, trade shows, demonstrations, etc. that you liked? If you were going to give or be a part of a seminar about water quality and grazing land what approach would you take and what would you include?

What We Have Learned

Several important insights have emerged from KGLWQP over the past five years. These insights were derived from staff field observations, dialogues with grazing resource managers, and from relevant literature.

- Pollutant sources are not always obvious. The source of water quality problems must be identified before they can be addressed.
- Water quality problems attributed to grazing land often originate from off site land uses such as cropland, roads and culverts. When water quality problems are caused by the grazing enterprise, they are typically attributable to livestock behavior.
- Each producer has a unique combination of managerial skills, resources and physiographic conditions. Appropriate management strategies and measures must be customized to each situation.
- To make informed management decisions concerning water quality, producers need reasonable cost/benefit estimates associated with alternative management strategies.
- An increased level of management may be needed to simultaneously satisfy water quality and economic objectives.
- Management of grassland ecosystems is complex relative to other agricultural land uses. Including water quality

protection in the management objectives will require a working understanding of the ecological, hydrological, and chemical processes that influence water quality.

WQFARE

The primary objective of KGLWQP was to develop a planning process to help producers identify and address water quality concerns. The process named Water Quality Financial Analysis and Resource Evaluation (WQFARE), was developed with the assistance of cooperators representing a variety of management styles, collectively managing over 23,000 acres of grazing land of varying forage types.

WQFARE is a five step process.

The first step is to inventory the physical landscape and the grazing management infrastructure. In this step, the landscape and vegetation characteristics of each pasture are identified and described. Vegetation characteristics include general species composition and overall condition of the pasture. The location of fences, stockwater, supplemental feeding, shade sources and other management facilities should be carefully recorded on aerial photographs or maps. The most effective inventory is obtained by evaluating a pasture several times during the season of use.

Step two is an evaluation of the current management system, including historical land use. This step includes a description of the class of livestock, stocking rate, grazing system used, the role of each pasture in the overall grazing system, season of use, and other management practices. This step also includes an inventory of labor and capital availability, and management resources of the producer.

Step three consists of an evaluation of the financial viability of the current management system. This step includes developing accrual adjusted beginning and ending balance sheets along with an enterprise-specific income statement for the existing management system. The current enterprise economic analysis provides a baseline profitability estimate from which to compare the economic projections associated with proposed changes.

Goal setting and developing alternative management strategies addressing water quality concerns are developed in step four. Once goals are set, strategy development focuses on manipulating fundamental management principles: stocking rate, grazing distribution, kind/class of livestock, systematic rest and nutrient management. Adjustment of these components to promote a more uniform grazing distribution (therefore more uniform vegetative cover) is usually a part of implementing alternative management strategies. Structural practices such as water developments and cross-fencing in addition to adjustments to grazing management principles may also be needed to relocate concentration and heavily-grazed areas away from water resources. Alternative measures should be developed based on the predictable response of livestock to those changes.

The last step in WQFARE is to analyze the economic feasibility of each proposed management strategy. Capital budgeting decision rules are recommended to evaluate potential improvements requiring long term capital investment. Other management changes will be evaluated using partial budgeting or full enterprise analysis. These procedures help determine which alternative management strategies are viable, and assist in ranking expected costs and benefits associated with the various alternatives. In some cases, the process helps to determine the amount of "cost share" funding that may be needed to implement a certain strategy or strategies.

Educational Program

WQFARE will be available in three alternative formats:

1. Trainer's Manual with detailed information -- Those working in education or technical assistance positions (such as Extension or NRCS personnel) will be the

primary audience for this format. After training, these personnel would subsequently provide individual assistance to producers wishing to incorporate water quality planning into their management strategies. This manual will include relevant research and experience related to water quality associated with grazing land to support the development of alternative management strategies. It will also include example water quality problems and solutions garnered from staff experience with cooperators. The manual will be in a notebook format to allow updating over time. A record of the personnel issued the manual will be maintained so that notebooks can be updated.

2. Producer Workshop -- This format will consist of a series of classroom instruction and follow-up field sessions. WQFARE and supporting material will be presented. Presentations will include examples depicting common water quality problems associated with grazing land followed by a discussion of possible solutions. The workshop will be coordinated with a notebook describing details of the financial analysis and resource evaluation process. Extension publications describing grazing management principles and examples of water quality improvement practices will be included in the material.

3. Producer Self Help -- The publication: *Managing Kansas Grazing Land for Water Quality* (MF-2086) March, 1995 will be revised to include an abbreviated description of WQFARE designed to allow producers to incorporate its concepts at their own pace. It will include references to supporting Extension publications including those being provided at workshops.

Extending Project Benefits

Although the grant supporting KGLWQP expires at the end of 2001, we have submitted proposals to extend program funding for three additional years. This funding would allow project staff to provide technical assistance using WQFARE directly to grazing land managers, and to provide training to interested professionals, such as County Extension Agents, NRCS personnel, and others. Note WQFARE will be incorporated into Extension programming even without renewed funding, but without funding, training responsibilities will rest exclusively with Paul Ohlenbusch and Rodney Jones. In this case, water quality practices might not be implemented at a pace that would benefit concurrent TMDL implementation.

Geographic Information System (GIS) support for producers wishing to implement WQFARE is another component of the mentioned 3-year grant proposal. We used GIS to delineate and locate fences, ponds, streams, feeders, and other features related to water quality. GIS allows for rapid analysis of grazing management scenarios that include variables such as range site production potential, pasture area, and distances of existing/proposed features such as fences or pipelines. In addition, detailed aerial photographs were provided to managers of the pastures inventoried by KGLWQP staff. Many producers indicated they found these photos helpful to overall management in addition to water quality planning.

Literature Database

The literature database is available on our project website and searchable by author, title, or keyword. Currently there are about 2,300 citations, of which 2,277 are available on-line. It will continue to be updated as long as the project is active. We have submitted a proposal requesting funding to transfer this database to the Hale Library to be permanently available.

The Watershed

K-STATE Kansas State University RESEARCH AND EXTENSION

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Ole's update

Fall has come and the weather continues normal! We are approaching the close of the project and working to finish up. We are also looking for funding to deliver the WQFARE Stewardship Program statewide to help landowners and operators develop watert quality oriented management. Sometimes I find items that provoke a new perception about agriculture. The item below is an example. "My countrymen have too little knowledge of the profits of grassland." – George Washington

WQFARE Workshop Report

We are pleased to announce the first WQFARE workshop was conducted at Frankfort, Kansas on Monday September 24th at the Frankfort Regional Education Center. Seventeen participants took part in this first session of a series of planned workshops to be held in the initial project study area. Participants included six cooperators, three invited producers, three Extension Agents, three Extension Watershed Specialists and two invited observers. This workshop covered pasture inventory methods for identifying water quality concerns on grazing land. These methods were subsequently applied and discussed on a nearby pasture owned by Dan and Mary Howell. The presentation also characterized areas of concern including exposed soil in close proximity to water resources. In addition, livestock responses to pasture features such as water location, shade and topography were discussed. By studying livestock behavior and its influence on sites of concern, the evaluator can identify problem source(s) and options for correcting them.

WQFARE Stewardship Program

In our last newsletter we introduced a 5 step planning process called Water Quality Financial Analysis and Resource Evaluation (WQFARE) and described three formats for its delivery. That combination of a Trainer's Manual for support personnel, producer workshops, and a self-help guide will hereafter be referred to as the WQFARE Stewardship Program. The Kansas Grazing Land Water Quality Program objective is to "promote voluntary management changes for improving water quality from Kansas grazing lands while maintaining profitability for landowners and operators."

We recognize maintaining profitability of an agricultural enterprise is a significant challenge regardless of its impact on water quality. Therefore, the financial analysis component of the planning process will play a central role in success of the program. Most operations can find opportunities to cut costs, improve production and/or capitalize on changing markets by keeping sufficient records and using them to analyze enterprise finances. Supporting the ability of landowners and operators to make sound financial decisions is an important step in encouraging stewardship.

We also recognize that the complex hydrological, ecological and economic systems influencing agriculture complicate the development of an effective water quality protection program. A guiding principle in the development of the WQFARE Stewardship program has been, "you must know and understand the situation before you can solve the problem." There can be no 'one size fits all' management prescription for protecting water quality on grazing land. Water quality protection strategies must be developed using local knowledge and an understanding of site characteristics, livestock behavior, and management history.

Our role is to simply provide producers with information and an approach for making informed decisions. Success of the program ultimately depends on a conservation ethic, commitment, and local knowledge being applied through the WQFARE planning process.

The Next Workshops

The next session in the pilot workshop series will be held at 1:15 on October 19th at the Frankfort Regional Education Center in Frankfort, Kansas. The first session covered how to conduct physical inventories for individual pastures; the next session will take a broader look at the goals and management of an entire grazing enterprise. This will include evaluating the current management of pastures in an example operation followed by an evaluation of the current economic status of that operation.

The final two sessions in this series of workshops will be held by late March. In these workshops we will look back at problems identified in the first workshop and work on development of strategies to address these problems.

Delivery of the WQFARE workshop series elsewhere in the state is anticipated.

Testing WQFARE on Your Own

During the period between workshops, producers were asked to implement steps of the program on at least one of their own management units. Some producers attending the first workshop identified parcels they would like to inventory. Aerial photos of these parcels have been mailed to these producers so they can go through step 1 of the WQFARE planning process on their own.

Staff will be available to respond to questions during and after the workshop or anytime at 785 532-5776

TMDL News

Due to a recent National Research Council report, the EPA wants to delay by 18 months the effective date of the TMDL rules published in the Federal Register on July 13, 2000. EPA also proposes to revise the date (from April 1, 2002 to Oct. 1, 2002) on which States are required to submit the next list of impaired waters under section 303(d) of the Clean Water Act.

For Federal Register details, go to: http://www.epa.gov/fedrgstr/EPA-WATER/2001/August/Day-09/w20017.htm

The NRC report referred to is entitled ``Assessing the TMDL Approach to Water Quality Management," and is accessible at: http://books.nap.edu/books/0309075793/html/1.html#pagetop

Water quality publications

The following is a list of publications we feel will benefit grazing resource managers who are integrating water quality planning into their overall management planning. Contact your County Extension office or project staff to obtain these publications or many of these are available on the Web at http://www.oznet.ksu.edu/library/

* Managing Kansas Grazinglands for Water Quality (MF-2086)
* Meeting Water Quality Challenges in Kansas (brochure)
* Grazing Distribution (MF-515)
* Using Conservation Buffers to Protect Water Quality and Enhance Agricultural Profitability (MF-2536)
* Stocking Rate and Grazing Management (MF1118)
* Kansas Grazing Land Management Notebook, 2000 Edition

Also of potential interest to grazing resource managers are the Total Maximum Daily Load (TMDL) Fact Sheets. To date, 6 factsheets have been developed. Of particular interest are:

Fact Sheet No. 1 TMDLs MF2459
Fact Sheet No. 4 Bacterial Contamination MF2460
Fact Sheet No. 6 Suspended Solids: A Water Quality Concern for Kansas MF2501

Below is a sample of additional useful publications that can be accessed on the Web.

National Management Measures to Control Nonpoint Source Pollution from Agriculture
http://www.epa.gov/owow/nps/agmm/

University of California Cooperative Extension Rangeland Watershed Program Fact Sheets
http://danr.ucop.edu/uccelr/htoc.htm

Project wind-down

We want to keep our readers abreast of select events which are going to take place as our project nears completion.

WQFARE Workshop October 19 1:15 PM Regional Ed. Center in Frankfort 2002

Grazing Management Workshops

*January 9 Rooks County
*January 10 Republic County
*January 16 Norton County
*January 17 Reno County
*January 22 Clay County
*January 23 Logan County

Feeding Practices and Stable Flies

Alberto Broce from the Department of Entomology, KSU recently contacted project staff about our experience with winter feeding practices. Conversations with Broce provided additional insights into how stable fly populations influence livestock concentration and how control is related to winter feeding practices. Since winter feeding practices are major factors in both grazing economics and water quality, we want to emphasize these relationships:

1) Feeding practices that avoid wastage and distribute hay over larger areas can enhance water quality and reduce stable fly numbers.
2) Stable fly bites often result in livestock behavior that can degrade water quality such as standing in water, concentration, and trampling of vegetation.
3) Enterprise profitability could be enhanced by hay feeding practices that distribute feeding sites over a wider area. This practice can reduce wastage, decrease stable fly population (decreased stress, increased water and forage consumption) and/or improve summer forage quality where hay was fed the previous winter.